

WHAT IS CLAIMED IS:

1. A thermal barrier coating for an underlying metal substrate which comprises a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0057 to about 1.0110 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizing metal oxide, the thermal barrier coating having:

1. a fraction of porosity of from about 0.15 to about 0.25; and
2. an impact and erosion resistance property defined by at least one of the following formulas:

$$(a) \quad I = \exp. [5.85 - (144 \times s) - (3.68 \times p)];$$

$$(b) \quad E = [187 - (261 \times p) - (9989 \times s)];$$

wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is at least about 70 g/mil; and E is at least about 80 g/mil.

2. The coating of claim 1 which has a strain-tolerant columnar structure.
3. The coating of claim 2 wherein the c/a ratio is in the range of from about 1.0069 to about 1.0096.
4. The coating of claim 2 wherein the fraction of porosity is from about 0.18 to about 0.20.
5. The coating of claim 2 which has an impact and erosion resistance property defined by both of formulas (a) and (b).
6. The coating of claim 5 wherein I is at least about 90 g/mil and E is at least about 100 g/mil.
7. The coating of claim 2 wherein the stabilizing metal oxide is selected from the group consisting of yttria, calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia,

and mixtures thereof.

8. The coating of claim 7 wherein the stabilizing metal oxide is selected from the group consisting of yttria, lanthana, and mixtures thereof.
9. The coating of claim 8 wherein the stabilizing metal oxide is yttria.
10. A thermally protected article, which comprises:
 - A. a metal substrate; and
 - B. a thermal barrier coating which comprises a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0057 to about 1.0110 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizing metal oxide, the thermal barrier coating having:
 1. a fraction of porosity of from about 0.15 to about 0.25; and
 2. an impact and erosion resistance property defined by at least one of the following formulas:
 - (a) $I = \exp. [5.85 - (144 \times s) - (3.68 \times p)]$;
 - (b) $E = [187 - (261 \times p) - (9989 \times s)]$;

wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is least about 70 g/mil; and E is least about 80 g/mil.
11. The article of claim 10 which further comprises a bond coat layer adjacent to and overlaying the metal substrate and wherein the inner layer is adjacent to and overlies the bond coat layer.
12. The article of claim 11 wherein the thermal barrier coating has a thickness of from about 1 to about 100 mils.
13. The article of claim 12 wherein the thermal barrier coating has a strain-tolerant columnar structure.

14. The article of claim 13 wherein the c/a ratio is in the range of from about 1.0069 to about 1.0096.
15. The article of claim 13 wherein the fraction of porosity is from about 0.18 to about 0.20.
16. The article of claim 13 wherein the thermal barrier coating has an impact and erosion resistance property defined by both of formulas (a) and (b).
17. The article of claim 16 wherein I is at least about 90 g/mil and E is at least about 100 g/mil.
18. The article of claim 13 wherein the stabilizing metal oxide is selected from the group consisting of yttria, calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia, and mixtures thereof.
19. The article of claim 18 wherein the stabilizing metal oxide is selected from the group consisting of yttria, lanthana, and mixtures thereof.
20. The coating of claim 19 wherein the stabilizing metal oxide is yttria.
21. The article of claim 13 which is a turbine engine component.
22. The article of claim 21 which is a turbine shroud and wherein the thermal barrier coating has a thickness of from about 30 to about 70 mils.
23. The article of claim 21 which is a turbine airfoil and wherein the thermal barrier coating has a thickness of from about 3 to about 20 mils.
24. A method for preparing a thermal barrier coating for an underlying metal substrate, the method comprising the step of:

a. depositing over the metal substrate a zirconia-containing ceramic composition having a c/a ratio of the zirconia lattice in the range of from about 1.0057 to about 1.0110 and stabilized in the tetragonal phase by a stabilizing amount of a stabilizing metal oxide selected from the group consisting of yttria, calcia, ceria, scandia, magnesia, india, lanthana, gadolinia, neodymia, samaria, dysprosia, erbia, ytterbia, europia, praseodymia, and mixtures thereof to form a thermal barrier coating having:

1. a fraction of porosity of from about 0.15 to about 0.25; and
2. an impact and erosion resistance property defined by at least one of the following formulas::

$$(a) \quad I = \exp. [5.85 - (144 \times s) - (3.68 \times p)];$$

$$(b) \quad E = [187 - (261 \times p) - (9989 \times s)];$$

wherein $s = 1.0117 - c/a$ ratio; p is the fraction of porosity; I is least about 70 g/mil; and E is least about 80 g/mil.

25. The method of claim 24 wherein a bond coat layer is adjacent to and overlies the metal substrate and wherein the thermal barrier coating is formed on the bond coat layer.
26. The method of claim 25 wherein the zirconia-containing ceramic composition is deposited by physical vapor deposition to form a thermal barrier coating having a strain-tolerant columnar structure.
27. The method of claim 26 wherein the thermal barrier coating is formed so as to have an impact and erosion resistance property defined by both of formulas (a) and (b).
28. The method of claim 27 wherein the thermal barrier coating is formed to have an impact and erosion resistance property defined by formulas (a) and (b) such that I is at least about 90 g/mil and E is at least about 100 g/mil.

29. The method of claim 26 wherein the thermal barrier coating is formed from a zirconia-containing ceramic composition stabilized with a stabilizing metal oxide selected from the group consisting of yttria, lanthana, and mixtures thereof.
30. The method of claim 27 wherein the thermal barrier coating is formed to have a fraction of porosity of from about 0.18 to about 0.20 and is formed from a zirconia-containing ceramic composition stabilized with yttria and having a c/a ratio in the range of from about 1.0069 to about 1.0096.